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Indian Standard

METHODS OF MEASUREMENTS ON CATHODE-RAY OSCILLOSCOPE (DC TO 10 Mc/s)

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INDIAN STANDARDS INSTITUTION
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NEW DELHI 110002

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Indian Standard

METHODS OF MEASUREMENTS ON CATHODE-RAY OSCILLOSCOPE (DC TO 10 Mc/s)

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Indian Standard

METHODS OF MEASUREMENTS ON CATHODE-RAY OSCILLOSCOPE (DC TO 10 Mc/s)

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 2 November 1967, after the draft finalized by the Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard prescribes the conditions and procedures for tests to be conducted on cathode-ray oscilloscopes covering ranges between dc and 10 Mc/s to determine their performance characteristics. The tests prescribed in this standard apply only to complete oscilloscopes and no separate consideration for the component parts has been given.

0.2.1 This standard does not cover methods of measurements of special facilities provided in certain types of cathode-ray oscilloscopes, such as two separate inputs to the vertical deflection system, multitrace and time-delay characteristics for radar work.

0.2.2 This standard does not also apply to special construction or particular purpose oscilloscopes, such as sampling oscilloscopes, vectorscopes and characteristic curve tracers.

0.3 This standard covers methods of measurements on the characteristics of cathode-ray oscilloscope under the following headings:

a) Vertical deflection performance,

b) Horizontal deflection performance, and

c) Miscellaneous characteristics.

0.3.1 Procedures for the measurement of the following characteristics are under consideration:

a) Delay in vertical deflection system,

b) Intensity (Z) modulation, and

c) Amplitude calibration.

0.3.2 Procedures for the measurement of the characteristics of triggered cathode-ray oscilloscopes are under consideration.

0.4 This standard lays down a single method of measurement for each characteristic so as to achieve the required degree of precision. It is not, however, intended to exclude other alternative methods of measurement for which necessary measuring equipment may be available and which are of equal or greater precision than the method prescribed in this standard.

0.5 The requirements of the different classes of oscilloscope are proposed to be covered in a series of standards, the first among them covering requirements for general purpose cathode-ray oscilloscope is under consideration.

0.6 In view of the fact that the markings on the oscilloscope indicating the model, designation, component location, current consumption, rated voltage and other significant particulars are helpful in conducting measurements, it was felt desirable to include a clause on information required by the testing authorities in Appendix A.

0.7 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard lays down the conditions and procedures for the tests to be conducted on cathode-ray oscilloscopes covering ranges between dc and 10 Mc/s to determine their performance characteristics.

1.1.1 These tests apply to complete oscilloscopes only and not to component parts thereof.

1.1.2 This standard does not apply to special construction or special purpose oscilloscopes, such as sampling oscilloscopes, vectorscopes and characteristic curve tracers.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions and explanations of terms shall apply.

2.1 General

2.1.1 *Magnitude of Signal Voltages and Currents* — This shall mean the peak-to-peak values unless otherwise specified.

2.1.2 *Mains Operation* — Operation of the instrument from a power source with an operating voltage over 24 volts, not solely used to supply power to the instrument.

*Rules for rounding off numerical values (*revised*).

2.1.3 *Cathode-Ray Oscilloscope* — An instrument used for observing or measuring the instantaneous values of one or more rapidly varying electrical quantities as either a function of time or of another electrical quantity. The instrument employs a cathode-ray tube as the indicating device.

2.1.4 *Waveform Distortion* — The unwanted change in the waveform occurring between the input and the display on the cathode-ray oscilloscope screen.

2.1.5 *Distortion Factor* — The ratio of the rms voltage of all harmonics combined to the total rms voltage.

2.1.6 *Percentage Distortion* — Distortion factor expressed as a percentage.

2.1.7 *Square Wave* — A periodic wave that alternately for equal duration of time assumes two fixed values, the time of transition being negligible in comparison with that duration.

2.1.8 *Rectangular Pulse* — A pulse whose waveshape has the profile of a rectangle, the rise and fall times being negligible compared with the pulse duration.

2.2 Cathode-Ray Tubes

2.2.1 *Cathode-Ray Tube* — An electron beam tube in which the beam can be focussed to a small cross-section on a surface and varied in position and intensity to produce a pattern either visible or otherwise detectable.

2.2.2 *Screen* — The surface of the tube upon which the visible pattern is produced.

2.2.3 *Spot* — A small area of the screen surface instantaneously affected by the impact of the electron beam.

2.2.4 *Measuring Area* — That part of the screen within which measurements can be made with defined accuracy.

2.2.5 *Intensity* — Brilliance of the spot or trace on the cathode-ray tube, normally adjustable.

2.2.6 *Focus* — The point of convergence of the cathode-rays impinging on the fluorescent screen.

2.2.7 *Astigmatism* — Failure of the focussing system to form a circular image. It is a focus defect in which electrons in different axial planes come to focus at different points.

2.3 Vertical and Horizontal Deflection System

2.3.1 *Sensitivity* — Peak-to-peak amplitude of the input signal necessary for one centimetre deflection of the trace.

2.3.2 *Amplifier* — The circuitry which provides amplification of the signal applied to the input terminals to obtain a defined deflection.

2.3.3 *Attenuator* — A device which provides the attenuation of a voltage according to defined ratios.

2.3.4 *Input Impedance* — The impedance measured between the input terminals in normal conditions of use. It is represented by the values of a resistor and a capacitor in parallel.

2.3.5 *Amplifier Band Width* — The frequency range within which the sensitivity does not change from the stated values by more than the specified limit.

2.3.6 *Response*

2.3.6.1 *Rise time* — The time required for the wave trace to rise from 10 percent to 90 percent of its peak amplitude ignoring possible overshoot and oscillations, for a rectangular pulse or a square wave (*see* Fig. 1).

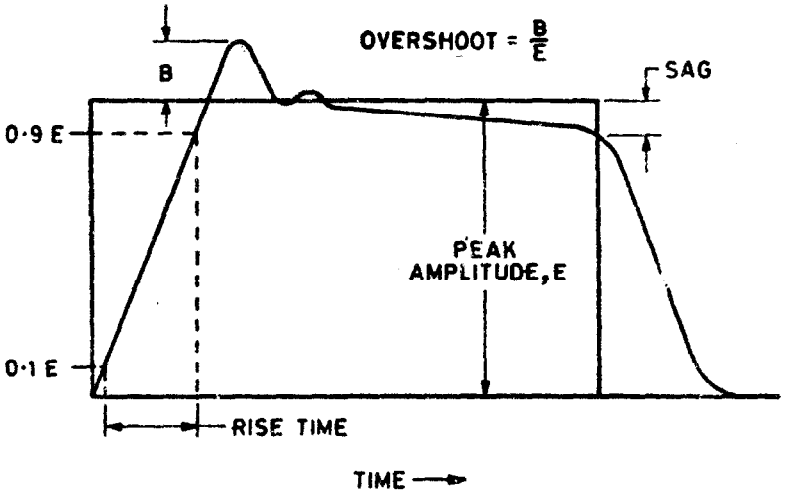

FIG. 1 PULSE SHAPE

2.3.6.2 *Sag* — The difference between the peak amplitude, ignoring the possible overshoot and oscillations, and the final amplitude of the wave trace, for a rectangular pulse or a square wave (*see* Fig. 1). It is expressed as a percentage of the peak amplitude for a given pulse duration.

2.3.6.3 *Overshoot* — That initial part of the wave trace which exceeds the peak amplitude, for a rectangular pulse or a square wave (*see* Fig. 1). It is expressed as a percentage of the peak amplitude.

2.3.7 *Drift* — The unwanted deviation of the vertical/horizontal trace of the spot in a specified time.

2.3.7.1 *Long term drift* — Maximum instability recorded during a specified period.

2.3.7.2 *Short term drift* — Maximum instability recorded during any specified interval within the specified period (*see* **2.3.7.1**).

2.4 Sweep Characteristics

2.4.1 *Sweep* — The horizontal trace of the spot, produced by the deflection of the electron beam, on the screen. This is generally achieved by feeding a saw-tooth wave to the horizontal plates of the cathode-ray tube from the time base.

2.4.2 *Nonlinearity of Sweep* — Maximum departure from the average rate of rise (slope) of the saw-tooth wave, applied to the horizontal plates. This factor is expressed in percentage:

$$\text{Nonlinearity of sweep} = \frac{\text{Maximum departure of slope rate}}{\text{Average uniform slope rate}} \times 100$$

2.4.3 *Jitter* — Unwanted fluctuations in the position of the display or a part of it, in a direction parallel to the sweep.

2.4.4 *Expansion (or Magnification)* — The process of increasing sweep speed, for example, by increasing the gain of the horizontal amplifier resulting in an expansion of a part of the unexpanded display.

2.4.5 *Synchronized Sweep or Locked Sweep* — A recurrent sweep synchronized so as to maintain the sweep period equal to, or to a multiple of, the period of the observed quantity.

2.4.6 *Triggered Sweep* — A sweep which is initiated by a trigger pulse (positive or negative) and having a rest position. The repetition rate need not be regular.

2.4.7 *Internal Synchronization (or Triggering)* — The synchronization (or triggering) obtained when the signal which controls the time base is supplied by an internal circuit influenced by the observed quantity.

2.4.8 *External Synchronization (or Triggering)* — The synchronization (or triggering) obtained when the signal which controls the time base is applied externally and independently of internal circuits influenced by the observed quantity.

2.4.9 *Synchronization (or Triggering) Frequency Range* — The frequency range for which the internal or external synchronization (or triggering) circuits permit a stable display.

2.4.10 *Synchronization (or Triggering) Threshold* — The minimum value of the synchronizing (or triggering) signal (external) or the minimum value of the vertical deflection (internal) which is necessary to obtain a stable display.

3. GENERAL CONDITIONS FOR MEASUREMENTS

3.0 Unless otherwise specified, measurements shall be made under normal measuring conditions as specified in **3.1** to **3.5.**

3.1 Normal Supply Voltage — Rated voltage shall be applied to the cathode-ray oscilloscope

3.1.1 The voltage applied to the cathode-ray oscilloscope shall be held constant within 2·0 percent of the rated value during the measurement of the characteristics.

3.1.2 In case of ac mains operation, the voltage shall be applied at the rated frequency. The harmonic content of ac mains supply voltage shall not exceed 5·0 percent.

3.1.3 In case of battery operation, primary or secondary batteries of the type and rated voltage as specified by the manufacturer, shall be used.

3.2 Standard Atmospheric Conditions for Tests

3.2.1 Unless otherwise specified, all tests shall be carried out under the following atmospheric conditions:

Temperature	Between 15°C and 35°C
Relative humidity	Between 45 percent and 75 percent
Atmospheric pressure	Between 860 mbar and 1 060 mbar

3.2.1.1 Where the conditions mentioned above have a significant influence, these shall be kept substantially constant during the test.

3.2.2 If the temperature limits as given in **3.2.1** are too wide for certain tests, these shall be conducted, or repeated in case of doubt, at a temperature of 27 $\pm$ 1°C and relative humidity of 65 $\pm$ 2 percent.

3.2.3 The instrument shall be protected from draughts and direct radiations.

3.3 Measurements

3.3.1 All the measurements shall be made under the conditions mentioned in each clause.

3.3.2 All the measurements shall be made after the initial warm-up period specified by the manufacturer.

3.3.3 *Initial Adjustment* — All measurements shall be made after carrying out preliminary settings recommended by the manufacturer.

3.3.4 Unless otherwise specified in the relevant clauses, all measurements shall be carried out within the measuring area.

3.4 Accuracy of Test Instruments — The test instruments employed to carry out the measurements in accordance with this standard shall have an accuracy of at least one order higher than that specified for the quantity under measurement.

3.5 Reporting — The test report shall clearly indicate the following:

a) Rated supply voltage,
b) Atmospheric conditions under which tests are carried out, and
c) Accuracy of test instruments.

4. PERFORMANCE OF VERTICAL DEFLECTION SYSTEM

4.1 Sensitivity — The sensitivity of the vertical deflection system shall be measured at a specified frequency at various calibrated values of sensitivity. A known magnitude (peak-to-peak value) of signal shall be fed to the vertical deflection input terminals of the cathode-ray oscilloscope so that the deflection of the waveform on the screen is about 80 percent of the measuring area. The magnitude of the signal deflection appearing on the screen shall be measured accurately. The sensitivity shall be computed from these measurements.

4.2 Linearity — The sensitivity of the vertical deflection system shall be measured as specified in **4.1** for various levels of input to the vertical deflection system starting from a signal input required for full deflection over the measuring area and reducing in suitable steps. At least five measurements shall be made. In case of dc operated cathode-ray oscilloscopes, the measurements shall be done both for positive and negative deflections. The linearity error shall be computed as the maximum percentage deviation of the sensitivities at different levels from the sensitivity measured in **4.1** (that is, sensitivity at about 80 percent deflection).

4.3 Frequency Response — With the vertical deflection system of the cathode-ray oscilloscope set at one of the calibrated sensitivity points, the sensitivity shall be measured at suitable intervals over the entire specified frequency range at a constant signal input level which does not overload the vertical deflection system of the cathode-ray oscilloscope. The sensitivity thus measured shall be plotted as a function of frequency. The measurements shall be repeated for different calibrated sensitivities.

4.4 Square Wave Response — Square wave response shall be checked for all the values of calibrated sensitivities. A pulse (having a rise time of about $0{\cdot}3t$ and of duration not less than $10t$, where t is the rise time of vertical deflection system of cathode-ray oscilloscope) of suitable magnitude

to produce a deflection of at least 80 percent of the measuring area shall be applied to the input terminals of the vertical deflection system. For this test the impedance of the pulse generator and the input circuit of the cathode-ray oscilloscope including the connecting cables shall be matched properly. The values of rise or fall time, overshoot and sag shall be measured (*see* **2.3.6**). The square-wave response measurements shall be carried out at pulse repetition frequencies corresponding to the lower and upper limit of the sweep frequency, the upper limit being limited to such a frequency that its third harmonic does not exceed the vertical amplifier bandwidth.

NOTE — This measurement is applicable only to the cathode-ray oscilloscopes incorporating a delay line.

4.5 Input Impedance

4.5.1 *ac Input Impedance* — The input impedance shall be measured over the specified frequency range and expressed in term of its equivalent parallel resistive and reactive components as a function of frequency. The measurements may be made with a Q-meter. The input terminals of the vertical deflection system shall be connected to the capacitance terminals of a Q-meter which is tuned for resonance at a frequency of, say, 100 kc/s, with a suitable inductor. The magnification factor Q_1 and the capacitance C_1 shall be noted. The Q-meter shall be retuned for resonance after disconnecting the oscilloscope terminals and the magnification factor (Q_2) and capacitance (C_2) are again noted. The input capacitance and resistance of the vertical deflection system of the cathode-ray oscilloscope is given by

a) Input capacitance = $C_1 - C_2$

b) Input resistance = $\frac{Q_1 \times Q_2}{2f C_2 (Q_2 - Q_1)}$, where f is the resonance frequency.

4.5.2 *dc Input Resistance* — The dc input resistance may be measured with a suitable impedance bridge.

4.6 Drift — During the measurement of drift, the supply voltage shall be kept constant within 1·0 percent, the supply frequency within 1·0 percent, ambient temperature at 27 ± 1°C and relative humidity at 65 ± 2 percent. The input terminals of the vertical and horizontal deflection systems shall be short-circuited and the sweep circuit switched off. The spot is then accurately focussed and the oscilloscope operated for a period corresponding to that specified for long term drift. During this period, the position of the spot is recorded either by direct measurement or by a photographic recording device, at intervals of time corresponding to that specified for short term drift. From the record obtained, the long term drift and short term drift are computed.

NOTE — This measurement covers both the vertical and horizontal deflection systems.

4.7 Linearity Error due to Positioning — A sinusoidal wave of such a magnitude as to give a vertical deflection of 20 percent of the measuring area shall be used as the test signal. With the positioning control adjusted to bring the display to the centre of the screen and with the test signal applied, the sensitivity shall be measured (K_1). With the positioning control adjusted to one extreme position the test signal shall be applied. The display shall be centred by super-imposing a low frequency square wave or dc and the sensitivity measured (K_2). The experiment shall be repeated with the positioning control adjusted to its other extreme position and with the trace centred with an external signal the corresponding sensitivity (K_3) shall be measured. The positioning error shall be expressed in percentage and shall be the highest of the following ratios:

$$\frac{K_2 - K_1}{K_1}, \frac{K_2 - K_1}{K_1}$$

4.8 Influence on Sensitivity

4.8.1 *Of Supply Voltage Variation* — This measurement shall be carried out at the highest sensitivity of the vertical deflection system of the cathode-ray oscilloscope. The mains voltage shall be varied over the specified voltage range in steps of 10 V. After maintaining the voltage at each step at least for one minute, the sensitivity shall be measured in accordance with **4.1**. The change in sensitivity shall be computed from these measurements.

4.8.2 *Of Supply Voltage Frequency* — Under consideration.

4.8.3 *Of Temperature Variation* — This measurement shall be carried out at the highest sensitivity of the vertical deflection system of the cathode-ray oscilloscope. The measurements specified in **4.1** shall be repeated at different ambient temperatures at steps of 10 deg over the specified operating temperature range. The sensitivity shall be measured at each temperature after thermal equilibrium is obtained at this temperature. The change in sensitivity shall be computed from these measurements.

4.8.4 *Of External Magnetic Field* — Under consideration.

5. PERFORMANCE OF HORIZONTAL DEFLECTION SYSTEM

5.1 Sweep Characteristics for Synchronized Cathode-Ray Oscilloscopes

5.1.1 *Sweep Rate* — The sweep rate shall be measured at various settings of the sweep rate control. From a suitable signal generator, signal shall be fed to the input terminals of the vertical deflection system so that at least five cycles appear on the screen over the specified measuring area. With the cathode-ray oscilloscope set on its internal synchronizing position

the input signal level and its frequency shall be adjusted to get a stationary pattern on the screen. The sweep rate shall be computed from these measurements.

5.1.2 *Linearity Error* — With the set-up for sweep rate measurements (*see* **5.1.1**) the period of each cycle of wave trace on the screen shall be measured. The linearity error shall be computed from these measurements.

5.1.3 *Internal Synchronizing Threshold* — With the set-up for sweep-rate measurement (*see* **5.1.1**), the synchronizing control, the input signal and the frequency of the signal generator shall be adjusted to determine the minimum input signal which when increased from zero level produces a stationary pattern. The input level thus obtained corresponds to the internal synchronizing threshold level.

5.1.4 *External Synchronizing Threshold Level* — The measurement shall be made as specified in **5.1.3** except that the cathode-ray oscilloscope shall be set at its external synchronizing position and the output of the signal generator shall be fed also to the external synchronizing terminals.

5.1.5 *Sweep Instability* — The sweep instability shall be checked at all settings of the sweep rate control. During these measurements, the supply voltage shall be kept constant within 1·0 percent, the supply frequency within 1·0 percent, the ambient temperatures at 27 $\pm$ 1°C and relative humidity at 65 $\pm$ 2 percent. This measurement shall be done with the synchronizing system put out of action. A sinusoidal signal of the known frequency shall be fed into the input terminals of the vertical amplifier deflection system. The sweep rate control shall be adjusted to obtain a practically steady pattern and the cathode-ray oscilloscope is operated for a period corresponding to that specified for long term drift. Any drift in the pattern shall be stabilized by adjusting the input frequency. The difference between the initial and final frequency will be a measure of the sweep drift. The drift shall be measured at intervals of time corresponding to that specified for short term drift over the specified period for long term drift.

NOTE — If synchronizing system cannot be put out of action, the measurement shall be made with the synchronizing control settings kept at minimum and this shall be stated in the report.

5.1.6 *Jitter* — The jitter shall be measured at the synchronizing threshold level (both internal and external), at the highest sweep rate and highest sensitivity of the vertial deflection system. A sinusoidal wave, the amplitude of which is equal to 25 percent of the measuring area, shall be fed into the input terminals of the vertical deflection system. The frequency of the input signal shall be adjusted so as to obtain one complete sinusoidal trace on the screen and the horizontal movement of the trace on the horizontal axis shall be measured. Jitter shall be measured as a percentage of full sweep length.

5.1.7 *Influence on Sweep Rate*

5.1.7.1 *Of supply voltage variation* — This measurement shall be carried out at all the settings of sweep rate control. The mains voltage shall be varied over the specified voltage range in steps of 10 V. After maintaining the voltage at each step at least for one minute, the sweep rate shall be measured in accordance with **5.1.5**. The change in the sweep rate shall be computed from these measurements.

5.1.7.2 *Of supply voltage frequency* — Under consideration.

5.1.7.3 *Of temperature variation* — This measurement shall be carried out at all the settings of sweep rate control. The measurements specified in **5.1.5** shall be repeated at different ambient temperatures at steps of 10°C over the specified operating temperature range. Sweep rate shall be measured at each temperature after thermal equilibrium is obtained at this temperature. The change in sweep rate shall be computed from these measurements.

5.1.7.4 *Of external magnetic field* — Under consideration.

5.2 Sweep Characteristics of Triggered Cathode-Ray Oscilloscopes — Under consideration.

5.3 External Signal Input Characteristics

5.3.1 *Sensitivity* — The sensitivity of horizontal deflection system shall be measured at various calibrated values of sensitivity at a specified frequency. A known magnitude (peak-to-peak value) of signal shall be fed to the horizontal deflection input terminals of the cathode-ray oscilloscope so that the deflection of the wave-form on the screen is about 80 percent of the measuring area. The magnitude of the signal deflection appearing on the screen shall be measured accurately. The sensitivity shall be computed from these measurements.

5.3.2 *Linearity* — The sensitivity of the horizontal deflection system shall be measured as specified in **5.3.1** for various levels of input to the horizontal deflection system, starting from a signal input required for full deflection over the measuring area and reducing in suitable steps. At least five measurements shall be made. In case of dc operated cathode-ray oscilloscopes, the measurements shall be done both for positive and negative deflections. The linearity error shall be computed as the maximum percentage deviation of the sensitivities at different levels from the sensitivity measured in **5.3.1** (that is, sensitivity at about 80 percent deflection).

5.3.3 *Frequency Response* — With the horizontal deflection system of the cathode-ray oscilloscope set at one of the calibrated sensitivity points, the sensitivity shall be measured at suitable intervals over the entire specified frequency range at a constant signal input level which does not

overload the horizontal deflection system of the cathode-ray oscilloscope. The sensitivity, thus measured, shall be plotted as a function of frequency. The measurements shall be repeated for different calibrated sensitivities.

5.3.4 *Input Impedance* — The input impedance shall be measured over the specified frequency range and expressed in terms of its equivalent parallel resistive and reactive components as a function of frequency.

The measurements may be made with Q-meter as specified in **4.5.1.**

5.3.5 *Linearity Error due to Positioning* — A sinusoidal wave of such a magnitude as to give a horizontal deflection of 20 percent of the measuring area shall be used as the test signal. With the positioning control adjusted to bring the display to the centre of the screen and with the test signal applied, the sensitivity shall be measured (K_1). With the positioning control adjusted to one extreme position the test signal shall be applied. The display shall be centred by superimposing a low frequency square wave or dc and the sensitivity measured (K_2). The experiment shall be repeated with the positioning control adjusted to its other extreme position and with the trace centred with an external signal, the corresponding sensitivity (K_3) shall be measured. The positioning error shall be expressed in percentage and shall be the highest of the following ratios:

$$\frac{K_3 - K_1}{K_1}, \quad \frac{K_2 - K_1}{K_1}$$

5.3.6 *Influence on Sensitivity*

5.3.6.1 *Of supply voltage variation* — This measurement shall be carried out at the highest sensitivity of horizontal deflection system of the cathode-ray oscilloscope. The mains voltage shall be varied over the specified voltage range in steps of 10 V. After maintaining the voltage at each step at least for one minute, the sensitivity shall be measured in accordance with **5.3.1.** The change in sensitivity shall be computed from these measurements.

5.3.6.2 *Of supply voltage frequency* — Under consideration.

5.3.6.3 *Of temperature variation* — This measurement shall be carried out at the highest sensitivity of the horizontal deflection system of the cathode-ray oscilloscope. The measurements specified in **5.3.1** shall be repeated at different ambient temperatures at steps of 10 deg over the specified operating temperature range. The sensitivity shall be measured at each temperature after thermal equilibrium is obtained at this temperature. The change in sensitivity shall be computed from these measurements.

5.3.6.4 *Of external magnetic field* — Under consideration.

6. MISCELLANEOUS MEASUREMENTS

6.1 Phase Difference Between Vertical and Horizontal Deflection Systems — The phase difference between the vertical and horizontal deflection systems shall be determined by applying the same signal to the input terminals of the vertical and horizontal deflection systems. This test shall be made in a frequency range indicated by the manufacturer.

6.1.1 A sine wave signal of a frequency, say 1 kc/s and amplitude 1 volt shall be applied to the input terminals of the vertical and horizontal deflection systems with the controls adjusted to get a deflection of 4 cm in each axis on the screen. Without phase difference a straight line is observed on the screen. With mutual phase shift this straight line becomes an ellipse (*see* Fig. 2). The value of the phase difference is given by the formula:

$$\sin \phi = \frac{h}{H}$$

where

h = part of the vertical axis within the ellipse, and

H = height of the ellipse.

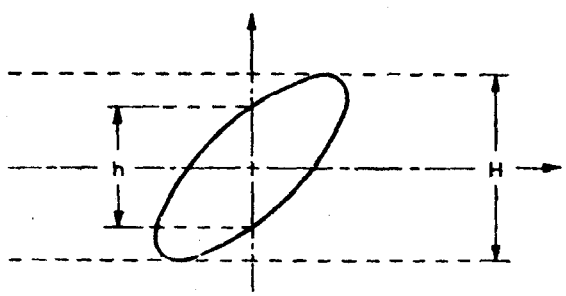

FIG. 2 MEASUREMENT OF PHASE DIFFERENCE BETWEEN VERTICAL AND HORIZONTAL DEFLECTION SYSTEMS

6.2 External Magnetic Radiation from Cathode-Ray Oscilloscope — Under consideration

6.3 Brightness — Under consideration.

6.4 Expansion Factor — The expansion factor shall be measured at various calibrated values of the expansion control. The sweep control shall first be set at an appropriate calibrated position and from a pulse generator, pulses of known duration shall be fed to the input terminals of the vertical deflection system so that sufficient number of pulses appear on the screen over the specified measuring area. The pulse duration should be of such a magnitude as to produce trace width (of each pulse) of at least 5 mm

on the screen. The sweep control shall then be adjusted to obtain stationary pattern. The width of the pulses shall be measured initially and at various positions of the expansion control. From these measurements, the expansion factor shall be computed.

APPENDIX A

(*Clause* 0.6)

INFORMATION REQUIRED BY TESTING AUTHORITY

A-1. MARKING

A-1.1 Unless otherwise specified, the following information shall be indelibly marked on the cathode-ray oscilloscope:

a) Serial number, and

b) Model designation.

A-1.2 A printed label of adequate size shall be affixed to one of the inner faces of the cabinet or back cover giving the following information:

a) Type of supply and operating voltage,

b) Maximum power consumption,

c) Plan of the chassis showing the location of the main components,

d) Maximum signal handling capacity, and

e) Any other information or caution which the manufacturer may consider necessary.

(*Continued from page 2*)

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